AUTOMATION AND MECHANIZATION

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AUTOMATION OF PNEUMATIC TRANSPORT OF GLASS BATCH COMPONENTS

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The operation of a pneumatic transport system for material components of a glass batch is analyzed. A system for automatic control of the executive mechanisms of the system based on a TA-23B pneumatic barrel pump is implemented using a microprocessor system and a control panel.

The use of automated systems to control pneumatic transport of glass batch components makes it possible to significantly increase the efficiency of processing and transporting of raw materials and to reduce losses of soda ash, lime, dolomite, and sodium sulfate [1].

These materials are commonly transported by pneumatic pressure systems equipped with pneumatic barrel pumps TA-23B with automatic control panels. However, the limited capabilities of the control panels supplied with the pumps do not allow for their efficient integration with automated systems controlling the glass batch production processes.

The pump control panel (PCP) developed at Stromizmeritel' JSC company is intended as a unit of a centralized automatic control system for batch production and can be used as a local control unit to manage exclusively the pneumatic transport flow.

The PCP is a dust-proof and moisture-proof hinged cabinet with a front panel containing mode switches, manual control buttons, and a graphic panel with LED indicators. Inside the cabinet there are a power unit, a control module based on a programmable logical matrix, a module connected with the automated control system of the batch production process, and eight power lines controlling the executive mechanisms of the pneumatic transport facilities.

The system for pneumatic transport of soda (Fig. 1) controlled by the PCP consists of a barrel pump *1* with a bottom discharge of material, a supply bunker *2* with a vibrator *3*, a lump crusher *4*, a charging valve *5* with a pneumatic actuator *6* of the disk gate valve, an air-outlet valve *7*, an air-inlet valve *8*, a pipeline gate *9* with a pneumatic actuator *10*, and a valve *11* for blowing the pipeline *12*. When transporting materials not prone to lumping, such as dolomite, the lump crusher is not used, and a screw feeder or a pneumatic tube can be installed instead of the crusher in the case of a non-coaxial position of the barrel pump and the supply bunker [2]. The vibrator can be replaced by a vibrating bottom, which more effectively prevents bridging over of the material in the supply bunker in front of the barrel pump.

The operation of the pneumatic transport system is controlled using sensors *13* and *14* indicating the minimum and the maximum compressed-air pressure in the pneumatic system and the barrel pump, the level indicator *15*, the rotation

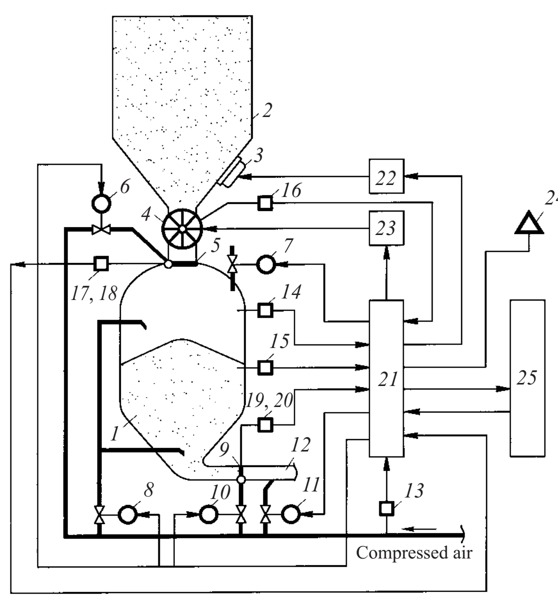

Fig. 1. Control system of a pneumatic transport system for soda.

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sensor *16* of the crusher (or of the screw feeder), and sensors *17 – 20* indicating the open and the shut positions of the charging valve and the pipeline gate. The panel *21* implies the possibility of blocking the rotation sensors, the sensor of the open state of the charging valve, and the pipeline gate position sensor, as they do not form part of the standard set supplied with the TA-23B pump.

The electric drives of the vibrator and the lump crusher are switched on using magnetic thyristor switches *22* and *23*. The siren *24* is used for emergency sound alarm and the microprocessor *25* ensures centralized monitoring and control of the technological equipment.

The pneumatic transport system operates as follows. An operator through respective switches on the front panel of the PUP selects an operation mode (remote automatic, local automatic, or manual mode) of the control system. In the remote automatic control model the barrel pump is switched on by the microprocessor control system, provided the following conditions are satisfied:

– the material level in the supply bunker is above the minimum level;

– the material level in the receiving hopper is below the maximum level;

– the pneumatic pipeline switch (in the case of a branching) is positioned accordingly;

– the charging valve and the pipeline gate are shut;

– the compressed air pressure inside the pneumatic system is normal;

– the air pressure inside the barrel pump is at minimum;

– there is no “Emergency” signal on the PCP.

After the control system automatically collects data from the sensors giving primary information and verifies the state of the mechanisms, it determined the readiness of the pneumatic transport system for operation, a start-up signal is issued and arrives at the control panel. According to the commands issued by the PCP, the air outlet valve and the pipeline blow valves are opened, and 4 – 5 sec later the disc gate valve and the charging valve are opened. Next, the lump crusher is switched on and the barrel pump starts to be filled with the material transported. The duration of charging is monitored and if it exceeds a prescribed value, a vibrator is switched on and intensifies the process of discharging the material from the supply bunker.

Charging of the barrel pump stops according to the signal received from the level sensor *15* in the following order: the lump crusher stops, the disk gate valve and the charging valve are shut, the air outlet valve and the pipe blow valve are switched off as well. Next, compressed air via the valve *8* is supplied into the upper part of the barrel pump to develop the required pressure level. Air is supplied to the lower part of the pump barrel for loosening and aeration of the material in front of the pipeline gate. After a prescribed pressure level monitored by the sensor *14* is reached inside the barrel pump, the pipeline gate is opened, and the material mixed with air arrives at the pneumatic pipeline *12* and is transported into a receiving hopper or a precipitator cyclone.

The end of discharge is registered based on the pressure inside the barrel pump dropping to a minimum level. The pipeline gate is shut, and the valve *11* is switched to blowing the pipeline. At the same time, the feed of compressed air to the barrel pump is stopped and the air outlet valve is opened, through which the residual compressed-air pressure is released to the aspiration system. The discharge process ends, and a new cycle of the pneumatic transport system starts.

When the pneumatic transport system operates in the local automated mode, the system is switched on via a PCP located directly near the barrel pump. In this case a protocol of the system operation is not performed, the position of the pneumatic pipeline switch is not automatically controlled, and the readings of the level sensors of the supply and receiving hoppers are not taken into account. Otherwise the operation algorithm is similar to the operation of the pneumatic transport system under the remote automation mode.

The local mode of switching on the barrel pump and monitoring its executive mechanisms is implemented using the manual control buttons and the LED indicators installed on the front panel of the control system.

The PCP in all operation modes verifies the execution of the commands to open or shut the charging valve and the pipeline gate, registers switching-on of the lump crusher or a screw feeder, monitors the duration of the pressure rise in the barrel pump and charging and discharging of the material, and compares this duration to a preset time. When the technological parameters deviate from the norm, light and sound emergency signals are issued on the control panel and block the operation of the system until the cause of the emergency is eliminated.

The use of a reprogrammable logical matrix in the PCP in combination with a microprocessor control system based on a personal computer makes it possible to implement adaptive algorithms of controlling pneumatic transport systems including various modifications of barrel pumps and various technological equipment sets.

These PCP produced by Stromizmeritel’ JSC are successfully used in the material preparation division of the Mineralovodskii Glass Factory and are scheduled for installation at other factories.

REFERENCES

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